Figure 1: Cross sections for projectile electron loss measured as a function of incident charge for the different numbers of electrons lost (\(q\)). The curves represent the best fit to the measured data based on eqs. (1) and (2).

Multiple Electron Capture and Loss of 2 MeV/u Xe Ions in Nitrogen

V. Horvat and R. L. Watson

A representative set of cross sections for multiple electron capture and loss in single collisions of 2 MeV/u Xe ions in nitrogen gas has been measured as a function of the projectile incident charge. The results were fitted with analytical functions. The functions used were such that the values of their parameters varied in a systematic way as a function of the projectile incident charge and/or the charge change, so that any relevant cross section for projectile charge change could be estimated with reasonable accuracy.

Projectile electron loss cross sections \(F_{q,q^+}(q)\) measured as a function of incident charge (\(q\)) for the different numbers of electrons lost (\(q\)) are plotted in Fig. 1. The curves in the figure represent the \(q\)-dependence in the form of

\[
F_{q,q^+}(q) = a_1 \exp(-a_2 q) + a_3 \exp\left[-(q-a_4)^2/a_5\right], \tag{1}
\]

in which

\[
\log a_1 = b_1 - b_2 q \tag{2}
\]

\[
a_2 = b_3 - b_4 \exp(-b_5 q) \tag{3}
\]

\[
\log a_3 = b_6 - b_7 q \tag{4}
\]

\[
a_4 = b_8 - b_9 \exp(-b_{10} q) \tag{5}
\]

The values of the parameters \(b_1\) through \(b_{11}\) were determined in a least squares fitting procedure (on the log scale) using all available experimental data points simultaneously. However, it was found that the resulting values of \(a_1\) and \(a_4\) for \(q = 1\) did not agree with the trend followed by the values of those parameters for \(q \neq 1\). For that reason their values were determined in a separate fitting procedure. Apparently, the functional dependence of the cross section for single loss on the projectile incident charge is notably different from that for the other (non-single) loss cross sections.

Based on the good agreement with the measured data shown in Fig. 1, it may be assumed that eqs. (1) and (2) can be used to make
Figure 2: Cross sections for projectile electron capture measured as a function of incident charge for the different numbers of electrons captured ($q$). The curves represent the best fit to the measured data based on eqs. (3) and (4).

Figure 3: Same as Fig. 2, with a different horizontal scale.

Reasonable estimates of the electron loss cross sections for any given combination of $q$ and $q^+$ are plotted in Fig. 2. The curves in the figure represent the $q$-dependence in the form of

$$\ln F_{q,q^+}(q) = P - \left(\frac{q_o}{q}\right) \times x,$$

in which

$$P = \frac{1}{2} \exp[-0.5 (g_2^2 + g_3^2 q)] - g_4 q,$$

$$x = \frac{g_8}{g_9} + \frac{g_{10}}{g_10} \exp(-\frac{q}{g_10}).$$

The linear dependence of the logarithms of cross sections for projectile electron loss on ($q/o/q$) is illustrated in Fig. 3. Based on the good agreement with the measured data shown in Figs. 2 and 3, it may be assumed that eqs. (3) and (4) can be used to make reasonable estimates of the electron capture cross sections for any given combination of $q$ and $q$.

References